

WHAT IS CLAIMED IS:

1. A scanning unit for moving an object to be moved along at least one axis, comprising:

5 a first actuator for moving the object along a first axis, the first actuator having a pair of end portions, the object being attached to one of the end portions, the first actuator being held at a position in the vicinity of the center in dimension or the center of gravity thereof.

10 2. The scanning unit according to claim 1, wherein the first actuator comprises a stacked piezoelectric actuator which is extendable along the first axis.

15 3. The scanning unit according to claim 1, wherein the first actuator comprises a pair of stacked piezoelectric actuators and a connection member for connecting the stacked piezoelectric actuators in series, and the connection member is held.

20 4. The scanning unit according to claim 1, further comprising a second actuator for moving the object along a second axis different from the first axis.

5. The scanning unit according to claim 4, wherein the second actuator comprises a stacked piezoelectric actuator which is extendable along the second axis.

25 6. The scanning unit according to claim 4, wherein the second actuator has a pair of end portions, one of the end portions being connected with the first actuator and the other one of the end portion being

fixed.

7. The scanning unit according to claim 4, wherein the second actuator is held at a position in the vicinity of the center in dimension or the center of gravity thereof.

8. The scanning unit according to claim 7, wherein the second actuator has a pair of end portions, and one of the end portions is brought into contact with a part close to an end portion of the first actuator to which the object is attached.

9. The scanning unit according to claim 4, further comprising a third actuator for moving the object along a third axis different from both the first axis and the second axis.

10. The scanning unit according to claim 9, wherein the second actuator comprises a stacked piezoelectric actuator which is extendable along the second axis, and the third actuator comprises a stacked piezoelectric actuator which is extendable along the third axis.

11. The scanning unit according to claim 9, wherein the second actuator has a pair of end portions, one of the end portions being connected to the first actuator, the other one of the end portions being fixed, the third actuator having a pair of end portions, one of the end portions being connected to the first actuator, the other end of the end portions being fixed.

12. The scanning unit according to claim 9,  
wherein the second actuator is held at a position in  
the vicinity of the center in dimension or the center  
of gravity thereof and the third actuator is held at a  
5 position in the vicinity of the center in dimension or  
the center of gravity thereof.

13. The scanning unit according to claim 12,  
wherein the second actuator has a pair of end portions,  
one of the end portions being brought into contact with  
10 a portion close to an end portion of the first actuator  
to which the object is attached, the third actuator  
having a pair of end portions, one of the end portions  
being brought into contact with a portion close to the  
end of the first actuator to which the object is  
15 attached.

14. The scanning unit according to claim 9,  
wherein the second actuator and the third actuator  
comprises a common cylindrical piezoelectric actuator.

15. The scanning unit according to claim 1,  
20 further comprising: a movable member for holding the  
first actuator; a second actuator for moving the  
movable member along a second axis different from the  
first axis; and a first guide mechanism for restricting  
movement of the movable member along the first axis.

25 16. The scanning unit according to claim 15,  
wherein the second actuator comprises a pair of stacked  
piezoelectric actuators which are extendable along the

second axis, and each of the stacked piezoelectric actuators has a pair of end portions, one of the end portions being connected to the movable member, the other one of the end portions being fixed.

5        17. The scanning unit according to claim 16, wherein the first guide mechanism has a pair of elastic members provided on both sides of a movable plate along the second axis.

10        18. The scanning unit according to claim 15, further comprising: a third actuator for moving the movable member along a third axis different from both the first axis and the second axis; and a second guide mechanism for restricting movement of the movable member along the first axis.

15        19. The scanning unit according to claim 18, wherein the second actuator comprises a pair of stacked piezoelectric actuators which are extendable along the second axis, each of the stacked piezoelectric actuators having a pair of end portions, one of the end portions being connected to the movable member, the other one of the end portions being fixed, the third actuator comprises a pair of stacked piezoelectric actuators which are extendable along the third axis, each of the stacked piezoelectric actuators having a pair of end portions, one of the end portions being connected to the movable member, the other one of the end portions being fixed.

20. The scanning unit according to claim 19,  
wherein the first guide mechanism having a pair of  
elastic members provided on both sides of the movable  
plate along the second axis and the second guide  
5 mechanism has a pair of elastic members provided on  
both sides of the movable plate along the third axis.

21. The scanning unit according to claim 20,  
wherein the end portion of the stacked piezoelectric  
actuator of the second actuator is connected to the  
10 movable member through a third elastic member, and the  
end portion of the stacked piezoelectric actuator of  
the third actuator is connected to the movable member  
through a second elastic member.

22. The scanning unit according to claim 21,  
15 wherein the elastic members of the first guide  
mechanism have relatively high rigidity along the third  
axis but relatively low rigidity along the second axis  
and, on the contrary, the elastic members of the second  
guide mechanism have relatively high rigidity along the  
20 second axis but relatively low rigidity along the third  
axis.

23. The scanning unit according to claim 22,  
wherein the elastic member of the first guide mechanism  
includes a rectangular spring having an elongated slit  
25 extending along the third axis and the elastic member  
of the second guide mechanism includes a rectangular  
spring having an elongated slit extending along the

second axis.

24. The scanning unit according to claim 9,  
further comprising a movable member which supports the  
second actuator and is supported by the third actuator,  
5 the second actuator having a pair of end portions, one  
of the end portions being connected to the first  
actuator, the other one of the end portions being  
connected to the movable member, the third actuator  
having a pair of end portions, one of the end portions  
10 being connected to the movable member, the other one of  
the end portions being fixed.

25. The scanning unit according to claim 24,  
wherein the first actuator comprises a pair of stacked  
piezoelectric actuators and a connection member for  
15 connecting the stacked piezoelectric actuators in  
series.

26. The scanning unit according to claim 25,  
wherein the second actuator comprises a stacked  
piezoelectric actuator which is extendable along the  
20 second axis, and the third actuator comprises a stacked  
piezoelectric actuator which is extendable along the  
third axis.

27. The scanning unit according to claim 25,  
further comprising a first guide mechanism for  
25 restricting movement of the movable member along the  
first axis.

28. The scanning unit according to claim 27,

wherein the first guide mechanism includes an elastic hinge mechanism.

29. The scanning unit according to claim 28,  
wherein the elastic hinge mechanism includes a pair of  
5 elastic members provided on both sides of the movable  
member along the second axis.

30. The scanning unit according to claim 27,  
wherein the first guide mechanism includes a minute  
10 ball rolling guide.

31. The scanning unit according to claim 30,  
wherein the minute ball rolling guide includes a base  
plate positioned under the movable member, a plurality  
of minute balls arranged between the base plate and the  
movable member, a pressing plate arranged above the  
15 movable member, a plurality of minute balls arranged  
between the pressing plate and the movable member, and  
a plurality of screws for pressing the pressing plate  
against the base plate through the movable member and  
the minute balls.

20 32. The scanning unit according to claim 27,  
further comprising a second guide mechanism for  
restricting movement of the connection member of the  
first actuator along the first axis.

25 33. The scanning unit according to claim 32,  
wherein the second guide mechanism includes a minute  
ball rolling guide.

34. The scanning unit according to claim 33, wherein

the minute ball rolling guide includes a plurality of minute balls arranged between the movable member and the connection member, a pressing plate arranged above the connection member, a plurality of minute balls arranged between the pressing plate and the connection member, and a plurality of screws for pressing the pressing plate against the movable member through the connection member and the minute balls.

35. A scanning microscope for using a probe to observe a surface of a sample, comprising:

a probe arranged in the vicinity of a surface of a sample;

a cantilever for supporting the probe;

a scanning unit for relatively scanning the probe and the sample; and

a displacement detection system for detecting displacement of the cantilever based on the interaction of the probe and the sample,

the scanning unit including:

a first actuator for moving an object to be moved which is either the probe or the sample along a first axis, the first actuator having a pair of end portions, the object being attached to one of the end portions, the first actuator being held at a position in the vicinity of the center in dimension or the center of gravity thereof;

a second actuator for moving the object along a

second axis different from the first axis; and  
a third actuator for moving the object along a  
third axis different from both the first axis and the  
second axis,

5 the second actuator and the third actuator comprising a common cylindrical piezoelectric actuator.

36. A scanning microscope for using a probe to observe a surface of a sample, comprising:

a probe arranged in the vicinity of a surface of a sample;

a cantilever for supporting the probe;

a scanning unit for relatively scanning the probe and the sample; and

15 a displacement detection system for detecting  
displacement of the cantilever based on the interaction  
of the probe and the sample,

the scanning unit including:

20 a first actuator for moving an object to be moved which is either the probe or the sample along a first axis, the first actuator having a pair of end portions, the object being attached to one of the end portions, the first actuator being held at a position in the vicinity of the center in dimension or the center of gravity thereof;

25 a movable member for holding the first actuator;  
a second actuator for moving the movable member  
along a second axis different from the first axis;

a third actuator for moving the movable member along a third axis different from both the first axis and the second axis; and

5 a guide mechanism for restricting movement of the movable member along the first axis.

37. A scanning microscope for using a probe to observe a surface of a sample, comprising:

a probe arranged in the vicinity of a surface of a sample;

10 a cantilever for supporting the probe;

a scanning unit for relatively scanning the probe and the sample; and

15 a displacement detection system for detecting displacement of the cantilever based on the interaction of the probe and the sample,

the scanning unit including:

a first actuator for moving an object to be moved which is either the probe or the sample along a first axis, the first actuator having a pair of end portions, 20 the object being attached to one of the end portions, the first actuator being held at a position in the vicinity of the center in dimension or the center of gravity thereof;

25 a second actuator for moving the object along a second axis different from the first axis, the second actuator having a pair of end portions, one of the end portions being connected to the first actuator;

a movable member for supporting the second actuator;

a third actuator for moving the object along a third axis different from both the first axis and the 5 second axis, the third actuator having a pair of end portions, one of the end portions being connected to a movable member to support the movable member, the other one of the end portions being fixed; and

10 a guide mechanism for restricting movement of the movable member along the first axis.